

***FD2 VD  
Photon Detector  
System:***

**Cold Electronics  
(PoF and SoF)  
Progress, Status and  
Path forward**

FD2 PD Cold Electronics Workshop  
Brookhaven National Lab

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**it was a GREAT Workshop !!  
Thank you - BNL Host and Team**

after two years we re-started to meet again face to face

and

because the discussions and presentations allowed to focus on the  
**on the items on the critical path:**

- **finalize PoF system for power distribution (GaAs PoF)**
- Feature of Analog signal and SoF - options for optimization -
- Digital signal and SoF presented - important progress and interest to pursue (for implementation)
- PD layout on the Cathode, implementation of HV discharge risk mitigation (Faraday Shield). A conclusion document (jointly from BNL & FNAL) would be important to allow a sequence of pending decisions
- 30yrs lifetime qualification: all electronic components should be qualified, risk mitigation for long lifetime failures (redundancy, simple solution)

VD PDS aims to play a major role for Physics in FD2 - specially for low-energy UG rare signals. This means moving beyond T0 determination for TPC and accessing high resolution Calorimetric energy reco, good position resolution, high Time resolution, Very High Trigger efficiency down to low Threshold (in the 5-10 MeV deposited energy). [for VD (more than for HD) the goal is LArTPC and LArPDS: two detectors for one LAr Volume]

Ar Scintillation light (Pure liquid) emission is NOT a fully controlled (understood) phenomenon, depending upon a number of side effects that we do not control (and will not control completely) - (I started dealing with this maybe 20 yrs ago - from first PDS in Icarus and continuing with the WArP - DM experiment, and light detection R&D)

With the new Ar-Xe mixture currently baselined with FD2 VD module, the understanding of the light emission is far to be under any reasonable level of control/understanding (this includes time variation of the response)

On top of it, a large (completely unexpected) high single PE rate has been seen with surface operated LArPDS (MicroBooNE, ProtoDUNE-SP) - whose origin can be correlated with Ion Transport (Space Charge under high Cosmic rate on surface).

The only tool that so far allowed to keep under (some) control the reconstruction of light signal in term of genuine PEs (from Ar-Xe) - in presence of unavoidable N2 contamination - is to collect the full signal waveform (and monitor shape change periodically). We have 640 PD module (x 2 channels) [not a big number as in the LArTPC].. no reason to split in two different r/o groups.

On the opposite, need REDUNDANCY - the Digital r/o is an ideal option, if preferred (eg to reduce power needs) the low sampling rate (2 Msps) can be considered

**Longevity validation is a fundamental step [the authority and the experience of BNL to establish this is vital]**

**Simpler solutions (less active component in cold) is - to me - the more reliable mitigation for risk of failures over the long lifetime of the experiment**